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(71) Applicants:
• **ThyssenKrupp Metalúrgica Campo Limpo Ltda.**
13231-900 Campo Limpo Paulista-SP (BR)
• **ThyssenKrupp AG**
45143 Essen (DE)
• **Universidade de São Paulo**
13566-590 São Carlos- SP (BR)

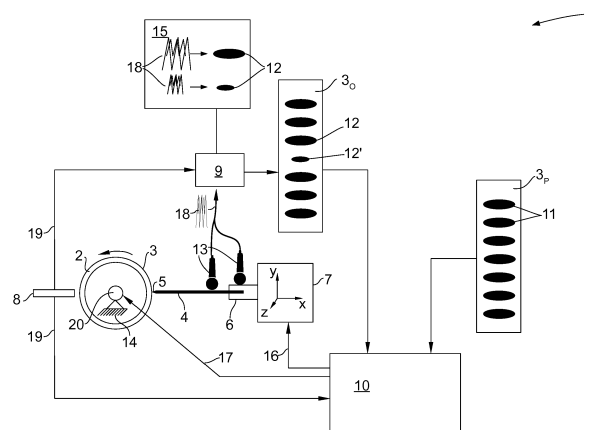
(72) Inventors:
• **BARBOSA DE OLIVEIRA FERREIRA SALLES, Bruno**
Sao Paulo (BR)
• **JANNONE DA SILVA, Eraldo**
13565-251 Sao Paulo (BR)
• **DE OLIVEIRA, Joao Fernando G.**
13565-251 Sao Paulo (BR)
• **CAMILLI BOTTENE, Alex**
13400-120 Piracicaba, SP (BR)

(74) Representative: **Kilchert, Jochen**
Meissner Bolte Patentanwälte
Rechtsanwälte Partnerschaft mbB
Postfach 86 06 24
81633 München (DE)

(54) **AN APPARATUS FOR DRESSING A GRINDING WHEEL**

(57) An apparatus (1) for dressing a grinding wheel (2) mounted thereon by creating structures (12) on the surface of a, in particular cylindrical, grinding surface (3) of the grinding wheel (2), the apparatus (1) comprising:
- a dressing tool holder (6) arranged for accommodating a dressing tool (4) in a dressing position,
- a controllable actuator (7) for adjusting the position of the tool holder (6) within the apparatus (1) in at least one direction (x),
- a grinding wheel support (14) for rotatably supporting a grinding wheel (2) to be dressed,

the apparatus (1) further comprises
means (13, 9) for monitoring an individual structure (12), created by the dressing tool (4) on the surface of the grinding wheel (2), and
means (8) for monitoring a circumferential position and/or the rotary speed (19) of the grinding wheel (2), and
means (10) for controlling the actuator (7), adapted to control the actuator (7) as a function of the monitored structure (12) and the monitored circumferential position and/or rotary speed (19).



Figur

Description

[0001] The present invention refers to an apparatus for dressing a grinding wheel and a method for controlling an apparatus for dressing a grinding wheel.

PRIOR ART

[0002] EP 0 876 875 A1 discloses a dressing apparatus having a CNC-control system. The dressing apparatus has a tool holder for accommodating a dressing tool, a CNC-controllable drive and a guide for moving the tool holder in such a manner, that the cutting position is movable in directions of at least two axes of a coordinate system. This dressing apparatus is used for the dressing of grinding wheels: Such grinding wheels are used for grinding several kinds of products. The quality of the created texture in particular deviates from the intended texture; improvements in the quality of the created texture are desirable.

DISCLOSURE OF INVENTION

[0003] Thus, the invention has the object to create a texture of high quality on the surface of grinding wheels.

[0004] This objective is achieved by an apparatus for dressing a grinding wheel taught by claim 1 and is achieved by a method for controlling an apparatus taught by claim 6. Preferred embodiments of the invention are defined by the sub-claims.

[0005] The invention provides an apparatus for dressing a grinding wheel mounted thereon by creating structures on the surface of a, in particular cylindrical, grinding surface of the grinding wheel, the apparatus comprising:

- a dressing tool holder arranged for accommodating a dressing tool in a dressing position,
- a controllable actuator for adjusting the position of the tool holder within the apparatus in at least one direction,
- a grinding wheel support for rotatably supporting a grinding wheel at the apparatus. The apparatus comprises further means for monitoring an individual structure, created by the tool on the surface of the grinding wheel, and means for monitoring a circumferential position and/or the rotary speed of the grinding wheel, and means for controlling the actuator, adapted to control the actuator as a function of the monitored structure and the monitored circumferential position and/or rotary speed.

[0006] Advantageously the invention provides the possibility to control the synchronisation between the circumferential position of a grinding wheel and the position of the dressing tool. The actuator may be a piezoelectric actuator, comprising a dressing tool holder associated in its free extremity. In particular a linear actuation of the actuator provides the contact between the dressing tool

and the grinding wheel surface or a variation of the dressing depth. In a predetermined circumferential position of the grinding wheel a contact between the dressing tool and the grinding wheel must be present to create the intended structures on the surface of the grinding wheel. Since the actuation of the actuator and thus the position of the tool is controlled as a function of the monitored structure and the monitored circumferential position and/or rotary speed, the structures can be created accurately on the predetermined position on the surface of the grinding wheel.

[0007] Further a quality control of the surface created on the grinding wheel surface is given by the correction of the rotation and by control of the dressing tool feed. This includes the possibility of mapping of the obtained texture for quality assurance. The creation of the structures thus depends on the circumferential position of the grinding wheel.

[0008] Under the term "structure" small irregularities on the surface of the grinding wheels are meant. These irregularities causes cavities on surface of the workpiece, which is later treated by the grinding wheel. These cavities on the workpiece serve for accommodating small amounts of lubricant during use of the workpiece. The entirety of all structures on the grinding surface is called the "texture" of the grinding wheel surface within the scope of this invention.

[0009] The means for monitoring a circumferential position and/or the rotary speed of the grinding wheel can be a magnetic sensor, in particular a hall-sensor. It is immaterial whether the sensor actually measures the rotary speed or the circumferential position over time, since the rotary speed can be calculated by differentiating the circumferential position and the circumferential position can be calculated by integrating the rotary speed. In an embodiment the sensor can be an inductive, capacitive, magnetic, photoelectrical or optical rotary speed or circumferential position sensor.

[0010] In an embodiment an analysing unit is provided, adapted to reconstruct a structure created on the surface of the grinding wheel, based on the information provided by the means for monitoring an individual structure and the means for monitoring a circumferential position and/or the rotary speed of the grinding wheel. Said means use a synchronism reading signal which is provided by said means for monitoring a circumferential position and/or the speed. Additionally, the synchronism reading signal is used to generate and amplify an image of the created structure.

[0011] According to an embodiment of the invention the means for monitoring an individual structure are adapted to monitor the individual structure at the instant moment during creation of this respective structure. This allows a real time controlling of the actuator, since deviations at the time of creation can be immediately recognized and corrected. The tool actuation can thus be coordinated by the feedback, which is provided by said means at the instant moment during creation, thus cor-

recting of errors and closer results of the initially desired structures can be obtained. The sensor for monitoring the structure can send the obtained signal to a structure representation system in real time. The structure reconstructed by the tool can be reconstructed based on historical data.

[0012] In an embodiment the means for monitoring the structure comprise an acoustic sensor for monitoring the noise, which is generated during creation of the respective structure, the acoustic sensor is in particular attached to the dressing tool and/or the dressing tool holder. This sensor records the noise, comprising in particular ultrasonic sound, which is generated when the tool immerses into the surface of the grinding wheel. The recorded noise is thus a real time representation of the structure, created at the time of recording. The recorded noise can be correlated to details of structures which are deposited in a database. By correlating the recorded noise and thus the obtained structure with the monitored circumferential position, the position of the created structure can be observed and monitored.

[0013] In an embodiment the means for controlling the actuator comprise numerical control means, enabling the input, compilation and transmission of information of machine commands without the intervention of an operator.

[0014] In an embodiment the apparatus comprises further means for comparing the monitored structure with a given predetermined structure and based on the result of the comparison adjusting at least one control pulse for controlling the actuator of the dressing tool and/or a motor for driving the grinding wheel. Said means can be integrated in the means for controlling the actuator. By comparing the monitored structure with a given predetermined structure a control circuit, in particular a real time control circuit can be established.

[0015] The objective is further solved by a method for controlling an apparatus as already described. The method comprises the following steps:

monitoring an individual structure created on the surface of the grinding wheel, and
monitoring the circumferential position and/or the rotary speed of the grinding wheel,
controlling the actuator of the dressing tool as a function of the monitored structure and the monitored circumferential position and/or rotary speed.

[0016] The advantages and further embodiments described with reference to the apparatus are also applicable to the claimed method.

EXAMPLE EMBODIMENT OF THE INVENTION

[0017] Further embodiments of the invention are subsequently disclosed with reference to the accompanied figure. The figure show a block diagram of an apparatus according to the invention.

[0018] The apparatus 1 comprises a grinding wheel

support 14 for rotatably supporting a grinding wheel 2 to be dressed within the apparatus 1. A motor 20 drives the grinding wheel 2 into rotation. A magnetic circumferential position sensor 8 is provided to monitor the actual circumferential position 19 of grinding wheel 2. By differentiating the several monitored circumferential position values a rotary speed of the grinding wheel is obtained.

[0019] A dressing tool 4 comprise a diamond tip 5, which during the dressing process gets in contact with the surface 3 of the grinding wheel 2. The dressing tool 4 is supported by a dressing tool holder 6. The position of the dressing tool holder 6 can be manipulated by an actuator 7 in various directions. In particular by varying the position of the dressing tool holder 6 in x-direction, the depth of immersion of the diamond tip 5 into the surface 3 of the grinding wheel 2 is adjusted.

[0020] A control unit 10 provides control pulses 16 for the dressing tool actuator 7. The control unit 10 is provided with data concerning the predetermined surface 3_p, which has to be created on the grinding wheel 2. Several predetermined structures 11 are provided within these data. Synchronization with the actual circumferential position of the grinding wheel 2 is provided by the circumferential position signal 19 of the grinding wheel 2.

[0021] An acoustic sensor 13 is provided for recording noise 18 occurring during immersion of the diamond tip 5 into the surface 3. Based on the immersion depth, the force, which is applied on the tip 5, the duration of the immersion and the area of the immersion, noises of different spectra 18 are generated. So when different structures are created on the surface noises of different frequencies and volumes, subsequently summarized under the term noise spectra 18, occur. A library of different noise spectra 18 is deposited in a database 15, along with details of structures 12 assigned thereto. By comparing the recorded noise spectra 18 with a noise spectra 18 deposited in the database 15 under consideration of the rotary speed signal 19 of the grinding wheel 2, a structure 12 can be determined, which is similar to the structure which was created during the recording of the respective noise 18. This determination is performed by an analysing unit 9, which has access to the data base 15. As a result the analysing unit 9 establishes an observed surface image 3_o comprising the structures 12 as monitored.

[0022] Due to wear of the dressing tool 4 or wear of bearing of the grinding wheel support 14 it may occur, that the accuracy of the dressing process is reduced in the course of time. As an example figure 1 shows in the observed surface 3_o a structure 12', which deviates from the predetermined structures 11. This indicates an undue wearout of the dressing tool 4. This wearout can be compensated by a respective change in the controlling of the actuator 7. For example the loss of diamond particles at the tip 5 can be compensated by an increased feed rate of the actuator 7 in x-direction. The apparatus and method according to the present invention provides the possibility of adapting the feed rate within a control circuit in

real-time.

LIST OF REFERENCE SIGNS

[0023]

1	apparatus
2	grinding wheel
3	surface of grinding wheel
4	dressing tool
5	diamond tip
6	dressing tool holder
7	dressing tool actuator
8	circumferential position sensor
9	analysing unit
10	control unit
11	predetermined structure
12	monitored structure
13	acoustic sensor
14	grinding wheel support
15	database
16	control pulse for dressing tool actuator
17	control pulse for motor
18	noise spectrum
19	circumferential position and/or rotary speed
20	motor

Claims

1. An apparatus (1) for dressing a grinding wheel (2) mounted thereon by creating structures (12) on the surface of a, in particular cylindrical, grinding surface (3) of the grinding wheel (2), the apparatus (1) comprising:

- a dressing tool holder (6) arranged for accommodating a dressing tool (4) in a dressing position,
- a controllable actuator (7) for adjusting the position of the tool holder (6) within the apparatus (1) in at least one direction (x),
- a grinding wheel support (14) for rotatably supporting a grinding wheel (2) to be dressed,

characterized in

that the apparatus (1) further comprises:

- means (13, 9) for monitoring an individual structure (12), created by the dressing tool (4) on the surface of the grinding wheel (2), and
- means (8) for monitoring a circumferential position and/or a rotary speed (19) of the grinding wheel (2), and
- means (10) for controlling the actuator (7), adapted to control the actuator (7) as a function of the monitored structure (12) and the monitored circumferential position and/or rotary

speed (19).

2. An apparatus (1) according to the previous claim, **characterized in** that the means (13, 9, 10) for monitoring an individual structure are adapted to monitor the individual structure (12) at the instant moment during creation of this respective structure (12).

3. An apparatus (1) according to any of the previous claims, **characterized in** that the means for monitoring the structure (12) comprise an acoustic sensor (13) for monitoring noise, which is generated during creating of the respective structure (12), the acoustic sensor (13) is in particular attached to the dressing tool (4) and/or the dressing tool holder (6).

4. An apparatus (1) according to any of the previous claims, **characterized by** an analysing unit (9), adapted to reconstruct a structure (12) created on the surface (3) of the grinding wheel (2), based on the information (18, 19) provided by the means (13, 9) for monitoring an individual structure and the means (8) for monitoring a circumferential position and the means (8) for monitoring the rotary speed or circumferential position of the grinding wheel (2).

5. An apparatus (1) according to any of the previous claims, **characterized in** that the apparatus (1) comprises further means (10) adapted for comparing the monitored structure (12) with a given predetermined structure (11) and means (10) adapted for adjusting at least a control pulse (16, 17) for controlling the actuator (7) of the dressing tool and/or a motor (20) for driving the grinding wheel (2) based on the result of the comparison.

6. A method for controlling an apparatus (1) for dressing a grinding wheel (2) by creating structures (12) onto a, in particular cylindrical, grinding surface (3) of the grinding wheel (2), the apparatus (1) comprising:

- a dressing tool holder (6) arranged for accommodating a dressing tool (4) in a dressing position,
- a controllable actuator (7) for adjusting the position of the tool holder (6) within the apparatus (1) in at least one direction (x),
- a grinding wheel support (14) for rotatably supporting a grinding wheel (2) to be dressed,

the method comprising the following steps:

monitoring an individual structure (12) created
on the surface of the grinding wheel (2),
monitoring the circumferential position and/or
the rotary speed (19) of the grinding wheel (2),
and
controlling the actuator (7) of the dressing tool
(4) as a function of the monitored structure (12)
and the monitored circumferential position
and/or rotary speed (19).

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7. The method according to the previous claim,

characterized in

the step of comparing the monitored structure (12)
with a predetermined structure (11),
wherein the step of controlling the actuator (7) of the
dressing tool is based on the result of this comparison.

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8. The method according to any of claims 6 or 7,

characterized in

that the respective structure is monitored at the instant moment during creation of this respective structure (12).

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9. The method according to any of claims 6 to 8,

characterized in

that the actual rotary speed or circumferential position of the grinding wheel is controlled on the basis of a predetermined rotary speed.

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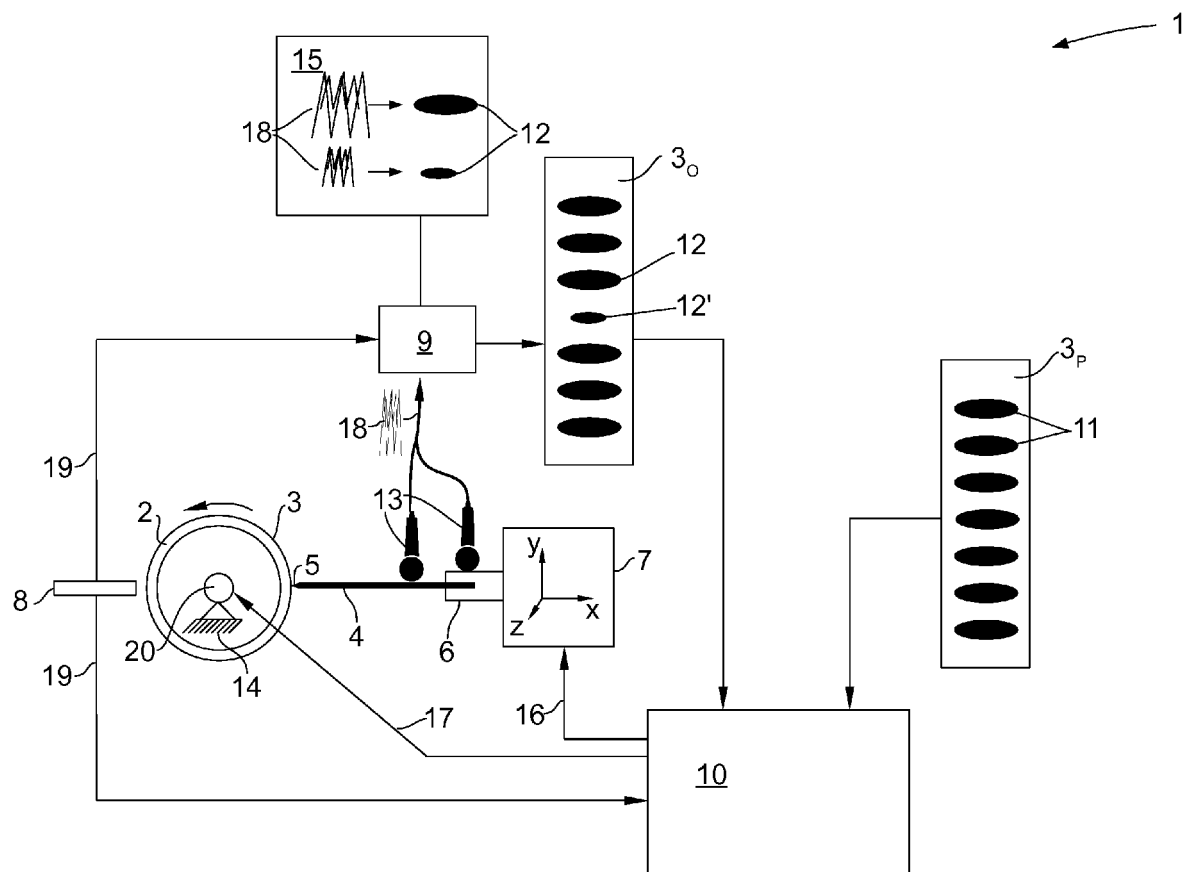
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Figur



EUROPEAN SEARCH REPORT

Application Number
EP 15 19 0814

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